The Shoulders We Stand On and the View From Here: Historiography and Directions for Research

NINA E. LERMAN, ARWEN PALMER MOHUN, AND RUTH OLDENZIEL

Our approaches to "gender and technology" are unabashedly interdisciplinary. Scholars studying technology and scholars explicating gender systems have provided us with a versatile set of tools for thinking about interactions of gender and technology in historical context. The articles collected in this special issue of *Technology and Culture* draw not only on the work of scholars within the community of this journal, but also on that of gender theorists, gender historians, and feminist sociologists of science and technology. In this essay we lay out a brief historiography, a map of the work we rely on.[1] We gather it as an invitation to others to join and extend a complex conversation.

Interdisciplinary exchange is a scholarly strategy more often prescribed than practiced. Its benefits are easy to recognize: fresh directions for research and new techniques for understanding familiar topics. Achieving them can be more difficult, however, requiring struggles with different standards for evidence and different uses

Our views of the material presented here have been shaped in myriad discussions with a substantial thought collective, many of whom appear in the notes that follow. This essay has benefited from readings and comments by Paul Edwards, Gabrielle Hecht, Christian Gelzer, Carolyn Goldstein, Helen Longino, Steven Lubar, Robert Post, Erik Rau, and John Staudenmaier. We dedicate this essay in thanks to the many foreparents cited here, in gratitude for their support, their example, and their scholarship.

[1]Most importantly, we recognize the modern Western bias of this discussion, a bias that reflects both the North American focus of the articles that follow and the Western focus of the scholarship treating gender and technology explicitly. Although they do not explicitly address questions of gender, we are indebted to Michael Adas and Bryan Pfaffenberger for clear arguments about the meanings attached to technology and the ways those meanings construct power relationships. See Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca, N.Y., 1989); Bryan Pfaffenberger, "Technological Dramas," *Science, Technology and Human Values* 17 (1992): 282–312.

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of language. We caution that moving from prescription to practice requires tolerance: this discussion stands at the confluence of several streams of scholarship, each of which has strengths and weaknesses. For example, feminist sociologists of technology have been very productive in analyzing the relationship between gender and technology in recent years. These studies, most of them ethnographies of contemporary innovations like computers and genetic engineering, tend to pay careful attention to rapid and recent patterns of technological change, but to be far less sophisticated in understanding slower-paced transformations in gender ideologies over time. Conversely, researchers studying gender in historical context tend to leave technological issues unexamined, neatly relegated to the "black box" scholars of technology have been at pains to open. Historians of technology, meanwhile, have been sluggish in their attention to masculinity as a crucial cultural dimension of the material they have traditionally studied, and reluctant to challenge familiar taxonomies (see the introduction to this volume). In addition to making this conversation possible, a tolerant attitude will reduce the amount of energy spent reinventing wheels: the existing scholarship is rich if diverse, and fragmented more now by academic divisions than by neglect of subject matter. Because of this diversity, the historiographic discussion below is followed by a topical treatment of more recent work.

The Shoulders We Stand On: Early Work on Women, Gender, and Technology

To discuss early work in women, gender, and technology is to discuss work in the history of technology, in women's history, and in the philosophy of science. The interdisciplinarity of this conversation has a long history, or rather several long histories, which converge at important points.

One of the great strengths of the Society for the History of Technology, and of this journal, has been a willingness to make room for a persistent group of explorers charting the integration of both women and gender analyses into a stubbornly masculine subject area. In the late seventies and early eighties, several scholars within the community attempted to introduce historians of technology to the new field of women's studies and feminist critiques of science and technology, scholarship concerned most centrally with the historical invisibility of women and the power attached to domains traditionally inhabited by men. Ruth Schwartz Cowan began this conversation in 1976 with her classic essay on the industrial revolution in the home. Instead of accounting for the supposed absence of

women in the technological realm, she showed that women's traditional sphere constituted a significant site of technological activity and that women were important technological actors rather than passive recipients of finished products. Her arguments were to have enduring significance.[2]

Soon thereafter, Martha Moore Trescott edited the first feminist collection of historical research on technology, *Dynamos and Virgins Revisited*, published in 1979. Trescott grouped the essays primarily by locale, in keeping with the "separate spheres" ideology women's historians were examining at the time. The essays in the first section dealt with "women as active participants in technological change" in industry, invention, and science; those in the second section treated "some of the effects of technology on women in the more private sphere of life," primarily the home and reproduction.[3]

Three years later Judy McGaw took the news of these and other research efforts back to the women's studies community in an essay appearing in *Signs: Journal of Women in Culture and Society*.[4] Although she addressed women's studies audiences, her essay served historians of technology equally well. It broached important historiographical questions and offered a detailed discussion of the existing literature with extensive footnotes. Our discussion here will focus on works published since her essay appeared in 1982.

If Cowan's arguments had recast women's traditional activities as a significant force in technological change, McGaw's essay convinc-

[2]Ruth Schwartz Cowan, "The 'Industrial Revolution' in the Home: Household Technology and Social Change in the 20th Century," *Technology and Culture* 17 (1976): 1–24, and "From Virginia Dare to Virginia Slims: Women and Technology in American Life," *Technology and Culture* 20 (1979): 51–63. In fact, Cowan brought technology to women's historians as early as the Berkshire Conference of 1973; see her brief essay "A Case Study of Technological and Social Change: The Washing Machine and the Working Wife," in *Clio's Consciousness Raised*, ed. Mary Hartman and Lois Banner (New York, 1976).

[3]Martha Moore Trescott, ed., *Dynamos and Virgins Revisited: Women and Technological Change in History* (Metuchen, N.J., 1979), quotes pp. 2–3. On women's changing roles, see the essays by Judith A. McGaw, Susan J. Kleinberg, and Susan Levine; on women as active participants, see the essays by Deborah Warner, Margaret Rossiter, and Trescott in the section titled "Women Inventors, Engineers, Scientists, and Entrepreneurs." Cowan's essay "The Industrial Revolution in the Home" was reprinted here as well. Trescott's title is a play on Lynn White, *Dynamo and Virgin Reconsidered: Essays in the Dynamism of Western Culture* (Cambridge, Mass., 1971); the original hardcover edition of White's book appeared as *Machina ex Deo* (Cambridge, Mass., 1968), and the title of that edition similarly inspired the title of Joan Rothschild, ed., *Machina ex Dea: Feminist Perspectives on Technology* (New York, 1983).

[4]Judith A. McGaw, "Women and the History of American Technology," *Signs* 7 (1982): 798–828.

ingly argued for the industrial workplace as well as the household as a site where women's interaction with technology should be studied. This call for research built on a growing body of literature on the sexual division of labor and skill.[5] It was of clear relevance to a history of technology community that was already discovering labor history through the work of David Noble, Merritt Roe Smith, Hugh Aitken, and others.[6] McGaw's essay also explained to historians of women's work that discussions about skill and de-skilling were by definition discussions of technology. And she insisted that the then-underexplored field of consumption, in addition to production, would require more careful examination from historians of women and of technology.

The same period produced another notable milestone when political scientist Joan Rothschild gathered within the pages of *Machina Ex Dea* the work of an interdisciplinary group of women scholars. Largely programmatic statements supported less by empirical studies than by theoretical insights, these rich if sometimes uneven essays introduced themes that would be central to the research agenda for the next ten years. They also issued calls for action and challenged what Rothschild called "a built-in resistance to the subject of women and technology" within the SHOT community.[7] This omission of

[5] Beginning with Harry Braverman's seminal *Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century* (New York, 1974), the function of mechanization in relations between employers and workers has been widely discussed. For critiques of Braverman see Paul Thompson, *The Nature of Work: An Introduction to Debates on the Labour Process* (London, 1983); Heidi Hartmann, "Capitalism, Patriarchy, and Job Segregation by Sex," *Signs* 1 (1976): 137–69, and "The Unhappy Marriage of Marxism and Feminism: Towards a More Progressive Union," *Capital and Class* 8 (1979): 1–33; Anne Phillips and Barbara Taylor, "Sex and Skill: Notes Towards a Feminist Economics," *Feminist Review* 6 (1980): 79–88.

[6] David F. Noble, *Forces of Production: A Social History of Industrial Automation* (New York, 1984) and "Social Choice in Machine Design: The Case of Automatically-Controlled Machine Tools," in *Case Studies on the Labour Process*, ed. Andrew Zimbalist (New York, 1979); Merritt Roe Smith, *Harpers Ferry Armory and the New Technology: The Challenge of Change* (Ithaca, N.Y., 1977); Hugh G. J. Aitken, *Scientific Management in Action: Taylorism at Watertown Arsenal, 1908–1915* (Cambridge, Mass., 1960; reprint Princeton, N.J.,1985).

[7] Rothschild, *Machina ex Dea*, quote p. xvii. See also Joan Rothschild, ed., *Women, Technology and Innovation* (New York, 1981), which appeared as a special issue of *Women's Studies International Quarterly* 4 (1981). These years produced several other feminist tracts: see, for example, Jan Zimmerman, ed. *Technological Woman: Interfacing with Tomorrow* (New York, 1983) and *Once Upon the Future: A Woman's Guide to Tomorrow's Technology* (London, 1986); Wendy Faulkner and Erik Arnold, eds., *Smothered by Invention: Technology in Women's Lives* (London, 1985).

women as actors in technological change was soon documented in more detail by John Staudenmaier.[8]

A product of their time, many of the essays in *Machina Ex Dea* went beyond historical analysis, offering a critique of the status quo and suggesting that women's values might come to be embodied in the design of dominant technologies.[9] But for historians, Rothschild made clear that it would not do simply to insert a few women into the historical record: "the very approaches to technology studies will have to undergo serious rethinking if work on women and technology is to be fully included and its impact felt in the entire field of study."[10] Autumn Stanley explained what that impact might look like: it would change the understanding of technology from what men do to what people do and would alter our ideas about what constituted significant technology.[11]

In 1985 another important collection, this time edited by sociologists Judy Wajcman and Donald MacKenzie, offered a sampling of

[8]John M. Staudenmaier, "What SHOT Hath Wrought and What SHOT Hath Not: Reflections on Twenty-Five Years of the History of Technology," *Technology and Culture* 25 (1984): 707–30, and *Technology's Storytellers: Reweaving the Human Fabric* (Cambridge, Mass., 1985).

[9]Arguments based on the premise that women are fundamentally different and therefore employ different values in choices of technological and scientific development are most often referred to as ecofeminism and/or essentialist feminism. Oft-cited examples include Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (San Francisco, 1983) and Carolyn Merchant's influential *The Death of Nature: Women, Ecology, and the Scientific Revolution* (New York, 1980), a summary of which appeared in Rothschild, *Machina ex Dea*, as "Mining the Earth's Womb, Dea Ex Machina." *Machina ex Dea* prominently featured this vein of scholarship; see, for example, Ynestra King, "Toward an Ecological Feminism and a Feminist Ecology," pp. 118–29. For more recent reiterations of this point of view, see Knut H. Sorensen, "Towards a Feminized Technology? Gendered Values in the Construction of Technology," *Social Studies of Science* 22 (1992): 5–32, and Rosalind Williams, "The Political and Feminist Dimensions of Technological Determinism," in *Does Technology Drive History? The Dilemma of Technological Determinism*, ed. Merritt Roe Smith and Leo Marx (Cambridge, Mass., 1994). See also related ideas in Janine Morgall's *Developing Technology Assessment: A Critical Feminist Approach* (Copenhagen, 1991), which argues for integrating women's interests in the early design stages of developing technologies. For a different variety of ecofeminism, see also Stacy Alaimo, "Cyborg and Ecofeminist Interventions: Challenges for an Environmental Feminism," *Feminist Studies* 20 (1994): 133–52, and the work of Donna Haraway (n. 15 below).

[10]Rothschild, *Machina ex Dea*, p. xvii.

[11]Autumn Stanley, "Women Hold Up Two-Thirds of the Sky: Notes for a Revised History of Technology," in Rothschild, *Machina Ex Dea*.

work in both the history of technology and sociology of technology.[12] Among other strengths, the volume gave sustained attention to gender in the construction of technology, in its introduction and in the selections presented. For example, the work of sociologist Cynthia Cockburn introduced historians of technology to the idea of exploring masculinity in traditional technological subjects, and of treating access to know-how as a source of social and political power. For sociologists, Ruth Schwartz Cowan's articles on the industrial revolution in the home and the development of the refrigerator demonstrated that the home, too, must be considered a site of technological activity. The work of Cowan and others situated technological change in historical context. Camouflaged as an undergraduate reader, the book provided another opportunity for the convergence of multiple streams of scholarship.

These developments in various fields close to the SHOT community paralleled an enormous avalanche of new developments in women's history in those years, as scholars began studying the full range of women's historical experience. Within the broad community of women's studies, historians made it clear that older essentialist interpretations were inadequate. Women's gender roles were not fixed but always changing; there was no innate, eternal woman's culture; the meanings of masculinity and femininity had been continually renegotiated through time and place and in relation to each other. Most of this early scholarship focused on middle class women in 19th-century America, for whom prescription dictated concern with a "domestic sphere" separate from a "public" one. Historians of women soon expanded their analyses to encompass other regions, nations, and time periods. Sustained attention to the lives of women of different social categories further deepened and complicated these understandings.[13]

[12] Donald A. MacKenzie and Judy Wajcman, eds., *The Social Shaping of Technology: How the Refrigerator Got Its Hum* (Philadelphia, 1985).

[13] Any choice fails to do justice to the sheer quantity and quality of this scholarship. A survey of article-length work can now be found in a massive and exhaustive compendium, Nancy Cott, ed., *History of Women in the United States: Historical Articles on Women's Lives and Activities,* 20 vols. (Munich and New York, 1992). Often-cited work includes Barbara Welter, "The Cult of True Womanhood, 1820–1860" *American Quarterly* 18 (1966): 151–74; Carroll Smith-Rosenberg, "The Female World of Love and Ritual: Relations between Women in Nineteenth-Century America," *Signs* 1 (1975): 1–29; Nancy F. Cott, *The Bonds of Womanhood: "Women's Sphere" in New England, 1780–1835* (New Haven, Conn., 1977). For a sampling of recent attention to the diversity of women's experience in the United States, see Vicki L. Ruiz and Ellen Carol DuBois, eds., *Unequal Sisters: A Multi-Cultural Reader in U.S. Women's History,* 2d ed., (New York, 1994). On essentialist feminism, see n. 9 above.

By the mid-1980s, Joan Scott, a historian of French social and labor history, could draw on this wealth of women's history and new cultural studies approaches. Her writings not only represented a culmination of the many historical studies that retrieved women's stories from the past, but also a new era in which scholars pushed the lessons of these studies to a higher analytical level by recasting them using the concept of gender. Scott announced a new analytical beginning. Many historians encountered the concept of gender first through Scott's work, finding her approach particularly useful because she incorporated historical contingency into her theoretical apparatus.[14]

Scott's essay "Gender: A Useful Category of Historical Analysis" made clear that gender theory could be not only a useful but also a central approach to understanding important historical themes. It laid out some of the layered ways in which she understood gender systems to operate. First, gender is part of human identity, the ways people see themselves and their lives as men and women. Second, gender plays structural roles in societies, defining barriers and boundaries, embedded in all manner of institutions such as education and labor markets. Finally, gender ideologies show up in symbolic forms: images and ideals of manhood and womanhood, gendered metaphors, masculine and feminine connotations of objects and activities. We have found these categories useful in understanding technology's history.

Finally, historians of technology also learned about gender theory from feminist philosophers of science. Their explanations of the nature of scientific knowledge, fragments of which appeared in early statements like Rothschild's *Machina Ex Dea,* have provided insights about gender and the power of knowledge and provoked new questions in approaches to technology. Unfortunately, the strength of their contributions to science studies has in some ways proved a hindrance to explorations of gender and technology in general, and historical research in particular: focusing on science, they have tended to privilege it in a way that ironically parallels its privileged stature in modern Western society; exploring primarily recent developments, they have encouraged the presentist conflation of science

[14]Joan W. Scott, "Gender: A Useful Category of Historical Analysis," *Journal of American History* 91 (1986): 1053–75. An expanded—and better known—version of this essay appeared in her *Gender and the Politics of History* (New York, 1988). Sandra Harding articulated a similar vocabulary in the field of feminist philosophy of science in *The Science Question in Feminism* (Ithaca, N.Y., 1986). Although influential in the late eighties, neither was the first; see Ann Oakley's use of "gender" in *Sex, Gender and Society* (London, 1972).

and technology (sometimes now referred to as "technoscience"). Nonetheless, by re-examining and carefully situating claims to expertise and definitions of knowledge, a range of authors including Evelyn Fox Keller, Sandra Harding, Helen Longino, and Donna Haraway continue to provide tools for rethinking approaches to technological knowledge and the layered meanings of technological activities.[15] Their approaches can be particularly helpful to historians of technology grappling with the relation of engineering knowledge to scientific knowledge.[16]

The View from Here: Current Work and Opportunities for Research

The range of current research in and opportunities for further study of gender and technology are challengingly diverse. In this section we describe some topics that have recently received scholarly attention and point to aspects ripe for rethinking, borrowing, or con-

[15] For a sampling of this literature, see Sandra Harding and Jean F. Barr, eds., *Sex and Scientific Inquiry* (Chicago, 1975); Harding and Merrill Hintikka, eds., *Discovering Reality: Feminist Perspectives on Epistemology, Metaphysics, Methodology, and Philosophy of Science* (Dordrecht, the Netherlands, Boston, and Hingham, Mass., 1983), which includes Nancy Hartsock's "The Feminist Standpoint: Developing Ground for a Specifically Feminist Historical Materialism," among other essays; Hilary Rose, "Hand, Brain, and Heart: a Feminist Epistemology for the Natural Sciences," *Signs* 9 (1983); Evelyn Fox Keller, *Reflections on Gender and Science* (New Haven, 1985); Donna Haraway, *Simians, Cyborgs and Women: the Reinvention of Nature* (London, 1988), which includes her now-classic essay, "A Manifesto for Cyborgs: Science, Technology, and Socialist Feminism in the 1980s," originally published in *Socialist Review* 15 (1985): 65–107; Harding, *The Science Question in Feminism*; Nancy Tuana, ed., *Feminism and Science* (Bloomington, Ind., 1989); Helen E. Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry* (Princeton, N.J., 1990) and her useful overview "Essential Tensions—Phase Two: Feminist, Philosophical, and Social Studies of Science," in *The Social Dimensions of Science*, ed. Ernan McMullin (Notre Dame, Ind., 1992); Lorraine Code, *What Can She Know: Feminist Theory and the Construction of Knowledge* (Ithaca, N.Y., 1991); Hilary Rose, *Love, Power and Knowledge: Towards a Feminist Transformation of the Sciences* (Bloomington, Ind., 1994). Scholars studying women, gender, and science gathered at the University of Minnesota, in May 1995, at a conference titled "The Women, Gender, and Science Question." Selected papers from that conference will appear in *Osiris*, ed. Sally Gregory Kohlstedt and Helen E. Longino (forthcoming).

Both Judy McGaw and Joan Rothschild have drawn on this literature in their later work; see Judith A. McGaw, "No Passive Victims, No Separate Spheres: A Feminist Perspective on Technology's History," and Joan Rothschild, "From Sex to Gender in the History of Technology," in *In Context: History and the History of Technology*, ed. Stephen H. Cutcliffe and Robert C. Post (Bethlehem, Penn., 1989).

[16] For an overview of discussions of engineering knowledge, and further citations, see Walter Vincenti, *What Engineers Know and How they Know It: Analytical Studies from Aeronautical History* (Baltimore, 1990). For further discussion of gender and technological knowledge, see Nina Lerman's article in this issue.

tinued exploration. This survey could be organized in a variety of ways; to some degree it defies organization. In the spirit of interdisciplinary conversation we have eschewed organization by discipline, choosing instead a topical approach grounded in the work at hand. This scholarship emphasizes, variously, technological actors, particular technologies, and sites of technological activity. In a loose fashion, we follow suit.

In surveying the literature of the past decade or so, some general trends emerge. In women's and gender studies, theoretical approaches and research strategies reflect the shift from exploring women to exploring gender described above. Earlier work sought to restore women to the historical narrative, focusing on women in male-dominated domains or acknowledging women's undervalued activities. In these studies, the question of whether technological changes had been a boon or a bane to women was often central. More recent work focuses on gender relationships, on both men and women, and asks questions about cultural practices and social systems.[17] In technology studies, scholars have in general continued to develop their emphasis on contextualization and on technological networks and systems. Both historians and sociologists have devoted increasing attention to social factors shaping technologies and to the "mutual shaping" of technology and society. In technology as in gender studies, recent work focuses on questions about cultural and social practices.

Recent scholarship on gender and technology begins to integrate these insights. So far, this scholarship tends to challenge traditional conceptions either in gender studies or in technology studies, while uncritically accepting familiar traditions in the other. For example, beginning with traditional technological subjects (presumed masculine), some scholars have explored particular tools, machines, or systems and their designers and inventors, seeking to restore women as contributors to technological change. Such explorations have then led to analysis of gender in relation to the subject at hand, whether invention or artifact. Here categories tend to be organized by particular technology such as cars or stoves, and incorporate gender by crossing boundaries from production to consumption. The importance of the artifact remains unchallenged. Alternatively, based on their understanding of the separate masculine and femi-

[17] A good introduction to recent scholarship on gender and technology is provided by Judy Wajcman, *Feminism Confronts Technology* (Cambridge, 1991). The bibliography is exceptionally good and includes literature from outside North America. Some additional bibliographical references may be found in Cynthia Gay Bindocci, *Women and Technology: An Annotated Bibliography* (New York and London, 1993).

nine spheres of paid workplace and domestic household, other scholars have documented the presence of technology in the household and of women in the industrial workplace. These discussions, too, have more recently moved to gender systems and relationships, for example, by exploring gender divisions of labor in a particular locus. The separation of private and public spheres is left intact. The challenge of full integration remains.

Technological Actors

New trends have had an impact even in the most entrenched and traditional areas in the history of technology. Older approaches, combined with popular connotations of "technology," have tended to make the very male world of invention and engineering look "normal," and thus even more exclusively male than is actually the case. Scholars seeking to restore women as contributors to technological change have relied on two primary strategies. Beginning in early efforts such as those appearing in *Dynamos and Virgins Revisited* and continuing in the larger projects they spawned, scholars have explored the individual struggles of women inventors, patent holders, and engineers to make a place for themselves in what has been defined as a traditionally male realm.[18] Examining broader social trends, historian of science Margaret Rossiter and sociologist Sally Hacker, among others, have tracked and documented the patterns of struggles and strategies of female engineers and scientists. They argue that women in the technical professions should not be seen as anomalies but should be considered an essential part of the pro-

[18] See Deborah J. Warner, "Women Inventors at the Centennial," in Trescott, *Dynamos and Virgins Revisited* (n. 3 above), and essays by Martha Moore Trescott and Autumn Stanley in the same volume. Trescott continued her work in "Lillian Moller Gilbreth and the Founding of Modern Industrial Engineering," in Rothschild, *Machina ex Dea* (n. 3 above), pp. 23–37, and "Women Engineers in History: Profiles in Holism and Persistence," in *Women in Scientific and Engineering Professions,* ed. Violet B. Haas and Carolyn C. Perrucci (Ann Arbor, Mich., 1984), pp. 181–205. Stanley's book *Mothers and Daughters of Invention: Notes for a Revised History of Technology* (Metuchen, N.J., 1993) is now available (see the review essay by Judith McGaw in this issue, which discusses this among other works). See also Stanley's article "The Patent Office as Conjurer: The Vanishing Lady Trick in a Nineteenth-Century Historical Source," in *Women, Work, and Technology: Transformations,* ed. Barbara Drygulski Wright et al. (Ann Arbor, Mich., 1987). For women inventors see also Anne L. Macdonald's anecdotal but rich *Feminine Ingenuity: Women and Invention in America* (New York, 1992) (also reviewed by Judith McGaw in her essay in this issue); Deborah J. Merritt, "Hypatia in the Patent Office: Women Inventors and the Law, 1865–1900," *American Journal of Legal History* 35 (1991): 235–306; and the review essay by Judith McGaw in this issue.

cess of (male) professionalization.[19] Other scholars, following the lead of Ruth Schwartz Cowan, reframed the household as a site of meaningful technological activity, and women as technological actors wherever they interact with technology. In combination, these scholars have demonstrated effectively that despite social barriers and stereotypical assumptions women have been absent only from the history of technology as written, not from its history as experienced.

As supposedly "natural" roles have been challenged, men and their interactions with technology have also become subjects of gender analysis. In the early eighties, British sociologist Cynthia Cockburn's pathbreaking work repeatedly demonstrated the importance of exploring gender in the male workplace to understanding technological change. Labor historians looking at gendered patterns of skill and automation followed close behind.[20] Within the SHOT community, Judy McGaw's 1989 essay "No Passive Victims, No Separate Spheres" challenged historians of technology to engage this emerging literature and include masculinity in their work, a challenge taken up by Carroll Pursell at the 1991 SHOT annual meeting in Madison, Wisconsin. In his address to a plenary session at that conference, and in a subsequent article, Pursell sought to encourage

[19] See Sally L. Hacker, *Pleasure, Power, and Technology: Some Tales of Gender, Engineering, and the Cooperative Workplace* (Boston, 1989) and Margaret W. Rossiter's brilliantly researched tomes, *Women Scientists in America: Struggles and Strategies to 1940* (Baltimore, 1982) and *Women Scientists in America: Before Affirmative Action, 1940–1972* (Baltimore, 1995). See also Carroll Pursell, " 'Am I a Lady or an Engineer?' The Origins of the Women's Engineering Society in Britain, 1918–1940," *Technology and Culture* 34 (1993): 78–97; Ruth Oldenziel, "Gender and the Meanings of Technology: Engineering in the U.S., 1880–1945" (Ph.D. diss., Yale University, 1992), chapter 6. For German case studies, see: Margot Füchs, *Wie die Väter, so die Töchter: Frauenstudium an der Technischen Hochschule München, 1899–1970* (Munich, 1994); Barbara Duden and Hans Ebert, "Die Anfänge des Frauenstudiums an der Technischen Hochschule Berlin," in *Wissenschaft und Gesellschaft: Beiträge zur Geschichte der Technischen Universität Berlin, 1879–1979,* ed. Reinhard Rürup (Berlin, 1979). Judith S. McIlwee and J. Gregg Robinson, *Women in Engineering: Gender, Power and Workplace Culture* (Albany, 1992), is an excellent study. On women in the professions see Joan Brumberg and Nancy Tomes, "Women in the Professions: A Research Agenda for American Historians," *Reviews in American History* 10 (1982): 275–96.

[20] Cynthia Cockburn, in *Brothers: Male Dominance and Technical Change* (London, 1983) and *Machinery of Dominance: Women, Men, and Technical Know-How* (London, 1985; reprint, with a foreword by Ruth Schwartz Cowan, Boston, 1988), early on described masculinity as a relationship to femininity. See also Mary Freifeld, "Technological Change and the 'Self-Acting' Mule: A Study of Skill and Sexual Division of Labour," *Social History* 11 (1986): 319–43; Ava Baron, "Contested Terrain Revisited: Technology and Gender Definitions of Work in the Printing Industry, 1850–1920," in Barbara Drygulski Wright, *Women, Work, and Technology.*

historians of technology to use analysis of masculinity as a tool for further understanding the engineers and technologies they knew well.[21] Historians of technology sit on a treasure-trove of detail about masculinity, most of it continuing in the age-old tradition of treating the male as norm and "normal," and thus genderless. For example, Robert Post's fine examination of the world of automotive hot-rodding never explicitly discusses the pervasive masculinity of this milieu.[22] Similarly, "shop culture" and "engineering culture" can be viewed as varieties of masculinity, as a wide array of scholars have pointed out.[23] Sustained attention to masculinity and its relation to femininity can illuminate the role of technologies in the construction of gender as well as the modern definition of technology as a male pursuit, and the power relations at stake in such a definition.

Broadening the definition of technological actor has made the concept a more flexible one, as not only inventors and designers but also factory workers and users can now be understood as agents in processes of technological change. Some scholars suggest that the concept of "actor" can encompass even nonhuman components of technological and social networks, broadening the definition still further.[24] For many historians, granting apparent agency to oceans

[21] McGaw, "No Passive Victims, No Separate Spheres" (n. 15 above); Carroll W. Pursell, "The Construction of Masculinity and Technology," *Polhem* 11 (1993): 206–19. This was not the first time he had written about the subject; see Carroll W. Pursell, "Toys, Technology and Sex Roles in America, 1920–1940," in Trescott, *Dynamos and Virgins Revisited.* See also Bruce Sinclair, "Technology on Its Toes: Late Victorian Ballets, Pageants, and Industrial Exhibitions" in Cutcliffe and Post, *In Context* (n. 15 above); Oldenziel, "Gender and the Meanings of Technology," chaps. 3–5. For general histories and sociologies on masculinity see, for example, Brian Easlea, *Fathering the Unthinkable* (London, 1981); Mark C. Carnes and Clyde Griffen, eds., *Meanings for Manhood: Constructions of Masculinity in Victorian America* (Chicago, 1990); Paul Willis, "Masculinity and Factory Labor," in *Working Class Culture,* ed. John Clarke et al. (London, 1979); Susan Johnson, "Bulls, Beans and Dancing Boys," *Radical History Review* 60 (1994): 4–37; E. Anthony Rotundo, *American Manhood: Transformations in Masculinity from the Revolution to the Modern Era* (New York, 1993); David D. Gilmore, *Manhood in the Making: Cultural Concepts of Masculinity* (New Haven, Conn., 1990). See also Arwen Mohun's article in this issue.

[22] Robert C. Post, *High Performance: The Culture and Technology of Drag Racing, 1950–1990* (Baltimore, 1994).

[23] See the work of Cynthia Cockburn, Ava Baron, Judy McGaw, Bruce Sinclair, Ruth Oldenziel, and Carroll Pursell, cited in nn. 19–21.

[24] For examples of social construction and actor network theory in technology studies, see Wiebe Bijker, Thomas Hughes, and Trevor Pinch, eds. *The Social Construction of Technological Systems* (Cambridge, Mass., 1987). For an argument in support of actor-network theory in studies of gender and technology, see Keith Grint and Rosalind Gill, *The Gender-Technology Relation: Contemporary Theory and Research* (London, 1995). For examples of other sociological and theoretical scholarship see Cheris Kramarae, ed., *Technology and Women's Voices: Keeping in Touch* (London,

and microbes, like considering pilot and airplane as a single "organism," runs counter to the exploration of human experience they see themselves undertaking. Nonetheless, the perspectives provided by considering all the people who interact with technology to be "technological actors" make social relations more visible and have transformed approaches to both artifacts and sites of technological activity.

An Emphasis on Artifacts

Most studies of technology have focused on a particular technology: refrigerators, steam engines, sewing machines. The increasing recognition of questions not only about what men and women do but also about how masculinity and femininity can be used symbolically has begun to inform examinations of modern technologies from automobiles to nuclear weapons.[25] In relation to both cars and airplanes, for example, historians have argued that women connoted safety and comfort even as they also drove racing cars and flew as barnstormers.[26] More importantly perhaps, recent studies have been able to show that cultural practices are never external, but always part and parcel of technological development: if the projected use of the bicycle for women prompted the successful development of the safety bicycle that was practical and safe, the failure of the electric car and the success of the combustion engine can also be traced to

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1988); Evelyn Fox Keller and Marianne Hirsch, eds., *Conflicts in Feminism* (New York, 1990); Gill Kirkup and Laurie Smith Keller, eds., *Inventing Women: Science, Technology and Gender* (London, 1992); Eileen Green, Jenny Owen, and Den Pain, eds., *Gendered by Design? Information Technology and Office Systems* (Bristol, Penn., 1993).

[25] Bryan C. Taylor, "Register of the Repressed: Women's Voice and the Body in the Nuclear Weapons Organization," *Quarterly Journal of Speech* 97 (1993): 267–85. Jane Caputi, "The Metaphors of Radiation: or, Why a Beautiful Woman is Like a Nuclear Power Plant," *Women's Studies International Forum* 14 (1991): 423–42; Paul N. Edwards, "The Army and the Microworld: Computers and the Politics of Gender Identity," *Signs* 16 (1990); Carol Cohn, "Sex and Death in the Rational World of Defense Intellectuals," *Signs* 13 (1987): 687–718; Joseph O'Connell, "The Fine-Tuning of a Golden Ear: High-End Audio and the Evolutionary Model of Technology," *Technology and Culture* 33 (1992): 1–37. For an introduction to work in the field of information and communication studies, see Liesbet van Zoonen, "Feminist Theory and Information Technology," *Media, Culture & Society* 14 (1992): 9–30; and Maureen Ebben and Cheris Kramarae, "Women and Information Technologies: Creating a Cyberspace of Our Own," in *Women, Information Technology, and Scholarship*, ed. H. Jeanie Taylor, Cheris Kramarae, Maureen Ebben (Urbana, Ill., 1993).

[26] Joseph J. Corn, "Making Flying 'Thinkable,' " chap. 4 in *The Winged Gospel: America's Romance with Aviation, 1900–1950* (Oxford, 1983); Virginia Scharff, *Taking the Wheel: Women and the Coming of the Motor Age* (New York, 1991; reprint, Albuquerque, N.M., 1992).

their gendered associations.[27] These case studies show that gender matters a great deal in the trajectory of technological change.

In addition, social scientists pursuing the "social shaping" or "social construction" of technology have come to emphasize the connectedness of all phases of technological development as relevant to questions of technological change. Studies focusing exclusively on invention or use, for example, are by definition limited and limiting. Integrating examination of design, manufacture, marketing, purchase, and use, on the other hand, allows a range of social and cultural factors, including gender, to become more apparent. Technological change is not a one-way street flowing from design to use; rather, design and use (and everything in between) mutually shape each other. Cockburn and Ormrod's *Gender and Technology in the Making*, a contemporary ethnographic study, encompasses all these stages. Following microwave ovens from factory to kitchen, the authors explored people's interactions with the artifact all along the way. Their work begs for historically situated companions.[28]

Several categories of artifacts merit further discussion, and further research. Recent studies of media and imaging technologies—what might be called "technologies of representation," such as photography, film, television, as well as medical diagnostic procedures such as ultrasound—mark a notable trend. These case studies benefit from more sophisticated understandings of symbolic and ideological aspects of gender systems as well as from an attention to the integration of production and consumption.[29] Because images of women

[27] Wiebe Bijker and Trevor Pinch, "The Social Construction of Artifacts," in Bijker, Pinch, and Hughes, *The Social Construction of Technology,* pp. 17–50; Scharff, *Taking the Wheel*; Rudi Volti, "Why Internal Combustion?" *American Heritage of Invention and Technology,* Fall 1990, 42–47; Mark Schiffer, *Charging the Wheel: Women and the Electric Car* (Washington, D.C., 1995).

[28] Cynthia Cockburn and Susan Ormrod, *Gender and Technology in the Making* (London, 1993). See also Lucille Alice Suchman, *Plans and Situated Actions: The Problem of Human-Machine Communications* (Cambridge and New York, 1987); and Danielle Chaubaud-Rychter's fine example, "Women Users in the Design Process of a Food Robot," in *Bringing Technology Home: Gender and Technology in a Changing Europe,* ed. Cynthia Cockburn and Ruza Fürst-Dilic (Buckingham, 1994).

[29] The following examples should point the interested reader to the broad issues here: Rosalind Petchesky, "Foetal Images: the Power of Visual Culture in the Politics of Reproduction," *Reproductive Technologies: Gender, Motherhood and Medicine,* ed. Michelle Stanworth (Cambridge, 1987) (other essays in this volume are also useful); Lynn Spigel, *Make Room for T.V.: Television and the Family Ideal in Post-War America* (Chicago, 1992); Susan Douglas, *Where the Girls Are: Growing Up Female with the Mass Media* (New York, 1994); Lisa Cartwright, *Screening the Body: Tracing Medicine's Visual Culture* (Minneapolis, Minn., 1995); Carole A. Stabile, *Feminism and the Technological Fix* (Manchester and New York, 1994) and "Shooting the Mother: Fetal Photography and the Politics of Disappearance," *Camera Obscura* 28 (1992): 178–205. The special

have been so pivotal in modern gender systems, this burgeoning field suggests ways in which technologies and gender ideologies are closely intertwined. It promises riches for the historian in the years to come.

Particular reproductive technologies, too—as Ruth Schwartz Cowan pointed out twenty years ago—deserve attention by historians of technology. While scholars in women's studies and women's history have produced a vast literature on reproductive and medical technologies, the pages of *Technology and Culture* have rarely reflected the extent of this research.[30] Early work focused on the question of whether new technologies would liberate women or provide tools of male intrusion and control of women's bodies.[31] Although political issues remain central in more recent work, current scholarship analyzes the complicated ways in which gender ideologies and reproductive technologies are shaping each other.[32] Recent histori-

issues on science and technology of this feminist film journal, vols. 28 and 29, deserve notice here. They were edited by Lisa Cartwright and Paula Treichler.

[30] Unfortunately, authors contributing to the special issue of *T&C* on biomedical and behavioral technologies had apparently not encountered this literature; *Technology and Culture* 34, no. 4 (1993).

[31] The earliest and classic "boon" statement dates from 1970 when Shulamith Firestone argued, in *The Dialectic of Sex: A Case for a Feminist Revolution* (New York, 1970), that the new technologies would be liberating for women. Socialist-feminists were the first to question Firestone's optimistic view of reproductive technologies, arguing that such technologies instead represented male intrusion of and control over the female body. Hilary Rose and Jalna Hanmer opened the black box of technology in "Women's Liberation: Reproduction and the Technological Fix," in *The Political Economy of Science: Ideology of/in the Natural Sciences*, ed. Hilary Rose and Steven Rose (London, 1976). Rita Arditti, Renate Duelli Klein, and Shelley Minden, eds., *Test-Tube Women: What Future for Motherhood?* (London, 1984) includes the different trends in the discussion. Highly critical assessments include Gena Corea et al., *Man-Made Women: How New Reproductive Technologies Affect Women* (London, 1985; reprint, Bloomington, Ind., 1987) and Gena Corea, *The Mother Machine: Reproductive Technologies from Artificial Insemination to Artifical Wombs* (New York, 1985). The influential and critical movement FINNRAGE (Feminist International Resistance to Reproductive and Genetic Engineering) announced itself in Patricia Spallone and D. L. Steinberg, *Made to Order: The Myth of Reproductive and Genetic Progress* (Oxford, 1987). For a response against the view of women as passive victims of male control and technology, see Stanworth, *Reproductive Technologies*. See also Patricia Spallone, *Beyond Conception: The New Politics of Reproduction* (London, 1989) and Patricia H. Hynes, ed., *Reconstructing Babylon: Essays on Women and Technology* (Bloomington, Ind., 1991).

[32] Barbara Katz Rothman, *Recreating Motherhood: Ideology and Technology in a Patriarchal Society* (New York, 1989); Rosalind Petchesky, "Foetal Images: the Power of Visual Culture in the Politics of Reproduction," in Stanworth, *Reproductive Technologies*; Jennifer L. Stone, "Contextualizing Biogenetic and Reproductive Technologies," *Critical Studies in Mass Communication* 8 (1991): 309–32; Laura R. Woliver, "The Influence of Technology and the Politics of Motherhood: An Overview of the United

cal work, too, has moved away from dichotomous boon-or-bane questions, as scholars seek to explore the technologies of childbirth, abortion, and contraception available to and chosen by women of the past, technologies often deliberately camouflaged in the written record.[33]

Tight connections between technologies and gender roles are also evident in a range of what we might call "technologies of identity," such as clothing, cosmetics, and other means of personal adornment. An increasingly sophisticated literature on fashion from corsets to suits and some recent work on the cosmetics industry points to a range of subjects worth further examination with attention to technological change.[34] In addition to this external redecorating, technological reshaping and redefining of the human body is also possible: studies of cosmetic surgery, genetic engineering, and sex change show that technological change can also take place below the surface of the skin, shaping gender identity in ways that have not yet reached the pages of *Technology and Culture*.[35]

States," *Women's Studies International Forum* 14 (1991): 479–90. Maureen McNeil, Ian Varcoe, and Steven Yearley, eds., *The New Reproductive Technologies* (London, 1990); José van Dijck, *Manufacturing Babies and Public Consent* (New York, 1995). On the Dutch debate, see Marta Kirejczyk, *Met technologie gezegend? Gender en de omstreden invoering van in vitro fertilisatie in de Nederlandse gezondheidszorg* (Utrecht, the Netherlands, 1996); Nelly Oudshoorn, *Beyond the Natural Body: An Archaeology of Sex Hormones* (London and New York, 1994); Marianne van den Wijngaard, *Reinventing the Sexes: Feminism and Biomedical Construction of Feminity and Masculinity, 1959–1985* (Amsterdam, 1991).

[33]For work published before 1982, see McGaw, "Women and the History of American Technology" (n. 4 above). For examples of more recent work see Rima D. Apple, ed., *Women, Health, and Medicine in America : A Historical Handbook* (New Brunswick, N.J., 1992); Margeret J. Sandelowski, "Failures of Volition: Female Agency and Infertility in Historical Perspective," *Signs* 15 (1990): 475–99; Susan E. Klepp "Lost, Hidden, Obstructed, and Repressed: Contraceptive and Abortive Technology in the Early Delaware Valley," in Judith McGaw, ed., *Early American Technology: Making and Doing Things from the Colonial Era to 1850* (Chapel Hill, N.C.,1994); Janet Farell Brodie, *Abortion and Contraception in Nineteenth-Century America* (Ithaca, N.Y., 1994); Laura Klosterman Kidd, "Menstrual Technology in the United States, 1854–1921," (Ph.D. diss., Iowa State University, 1994); Rachel Maines, "The Vibrator, the Dildo, and the Speculum: Androcentric Perceptions of Nineteenth-Century Technologies" (paper presented at the annual meeting of the Society for the History of Technology, London, August 1996).

[34]See Kathy Peiss, "Making Faces: The Cosmetics Industry and the Cultural Construction of Gender, 1890–1930," *Genders* 7 (1990): 143–69; Claudia Kidwell and Valerie Steele, *Men and Women: Dressing the Part* (Washington, D.C., 1989); Anne Hollander, *Sex and Suits* (New York, 1994); Valerie Steele, *Fashion and Eroticism: Ideals of Feminine Beauty from the Victorian Era to the Jazz Age* (New York, 1985). See also McGaw, "Women and the History of American Technology."

[35]For a sample of this emerging literature, see Kathy Davis, *Reshaping the Female Body: The Dilemma of Cosmetic Surgery* (New York, 1995); Bernice L. Hausman, *Chang-*

As these discussions suggest, scholars have come to regard the body—like the household or the factory—as a site of technological activity. Pacemakers, radiation, and hormone therapy allow machines to be part of bodies, and bodies to be regulated like machines. Often discussed under the rubric "cybernetic organisms" or "cyborgs," this blurring of boundaries between human and machine has profound implications for gender ideologies: for example, because the body has conventionally been a site and symbol of women's nature, these technological manipulations can raise crucial questions about traditional roles.[36] A careful historical perspective, however, is often missing from these discussions; from 18th-century automata to mechanistic views of human physiology, the nature of the interface between bodies and machines has a long and complex history. A prehistory of cyborgs, particularly one that takes gender into account, remains to be written.[37]

Separate Spheres, Separate Sites

More traditionally, discussions of sites of technological activity have been based in a conception of gender defined by separate male and female "spheres": "workplace" and "household." Linked as related aspects of "industrialization" by Ruth Schwartz Cowan twenty years ago, workplace and household have more often been considered as separate academic spheres, the first to be explored by labor historians, and the second by historians of women. This split has been particularly evident among North American scholars. Such

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ing Sex: Transexualism, Technology and the Idea of Gender (Durham, N.C., 1995); Ann Balsamo, *Technologies of the Gendered Body: Reading Cyborg Women* (Durham, N.C., 1996). See also Allucquere Stone, *The War of Desire and Technology at the Close of the Mechanical Age* (Cambridge, 1995).

[36]These discussions of blurring boundaries between what is "human" and what is "machine" owe much to the work of Donna Haraway (n. 15 above). For a recent statement see Haraway, "The Promises of Monsters," in *Cultural Studies*, ed. Lawrence Grossberg, Cary Nelson, and Paula A. Treichler (New York, 1992). For further discussion see also Paul N. Edwards, "Cyberpunks in Cyberspace: The Politics of Subjectivity in the Computer Age," in *The Cultures of Computing*, ed. Susan Leigh Star (London, 1995) and *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, Mass., 1996); and Ruth Oldenziel, "Of Old and New Cyborgs: Feminist Narratives of Technology," *Letterature d'America* (1996): 95–111.

[37]One intriguing path is through the small literature on how the historical process of industrialization has reshaped conceptualizations of the human body. See Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (New York, 1990); Mark Seltzer, *Bodies and Machines* (New York, 1992); and Barbara Duden, *Woman Beneath the Skin: A Doctor's Patients in 18th-Century Germany*, trans. Thomas Dunlap (Cambridge, Mass., 1991); "'Quick with Child': An Experience That Has Lost Its Status," *Technology in Society* 14 (1992): 335–44; and *Disembodying Women: Perspectives on Pregnancy and the Unborn*, trans. Lee Hoinacki (Cambridge, Mass., 1993).

distinctions are rooted in historiographical traditions that lie beyond the scope of this essay.

Attention to the experiences of women and more recently to gender has deeply affected the field of labor history. Over the last fifteen years, historians examining women's work and the gendered division of labor have questioned the overriding importance of class as a structural category; have broadened their purview to include workplaces such as department stores and offices; and have argued that the community as well as the shop floor must be studied to fully understand workers' experiences. Studies analyzing patterns of sexual division of labor, gendered construction of skill, and mechanization and de-skilling have perhaps been of greatest immediate interest to historians of technology.[38] Despite the extent of this literature, however, these approaches rarely focus on the workplace as a technological site where gender and technology interact.[39] Treating

[38]For overviews of these issues see Ava Baron's introduction to her edited *Work Engendered: Towards a New Labor History* (Ithaca, N.Y., 1991); Elizabeth Faue, "Gender and the Reconstruction of Labor History," *Labor History* 34 (1993): 169–79; Alice Kessler-Harris, "Treating the Male as 'Other': Re-defining the Parameters of Labor History," *Labor History* 34 (1993): 190–204. For examples of recent work on gender and skill see Margaret Lucille Hedstrom, "Automating the Office: Technology and Skill in Women's Clerical Work, 1940–1970" (Ph.D. diss. University of Wisconsin, 1988); Shirley Tillotson, "'We May All Soon Be 'First-Class Men': Gender and Skill in Canada's Early Twentieth Century Urban Telegraph Industry," *Labour* 27 (1991): 97–125; Wendy Gamber, "'Reduced to Science': Gender, Technology and Power in the American Dressmaking Trade, 1860–1910," *Technology and Culture* 36 (1995): 455–82; Laura Lee Downs, *Manufacturing Inequality: Gender Division in the French and British Metalworking Industries, 1914–1939* (Ithaca, N.Y., 1995); Sharon Hartman Strom, *Beyond the Typewriter: Gender, Class, and the Origins of Modern American Office Work, 1900–1930* (Urbana, Ill., 1992). The telephone industry has attracted disproportionate attention in recent years; see Michèle Martin, *'Hello, Central?' Gender, Technology, and Culture in the Formation of Telephone Systems* (Montreal, 1991); Kenneth Lipartito, "When Women Were Switches: Technology, Work, and Gender in the Telephone Industry, 1890–1920," *American Historical Review* 99 (1994): 1074–1111; Venus Green, "Race and Technology: African-American Women in the Bell System, 1945–1980" *Technology and Culture* 36, suppl. (1995): S101–44 and "Goodbye Central: Automation and the Decline of 'Personal Service' in the Bell System, 1878–1921," *Technology and Culture* 36 (1995): 912–49. For older literature see McGaw, "Women and the History of American Technology."

[39]Exceptions include Judith McGaw, *Most Wonderful Machine: Mechanization and Social Change in Berkshire Paper Making, 1801–1885* (Princeton, N.J., 1987); Patricia A. Cooper, *Once A Cigar Maker: Men, Women, and Work Culture in American Cigar Factories, 1900–1919* (Urbana, Ill., 1987) and "What this Country Needs is a Good Five-Cent Cigar," *Technology and Culture* 29 (1988): 779–807. See also Arwen Mohun, "Why Mrs. Harrison Never Learned to Iron: Gender, Skill, and Mechanization in the Steam Laundry Industry," *Gender and History* 8 (1996): 231–51, and Roger Horowitz's article in this issue.

workers as well as managers as technological actors profoundly influenced by gender ideologies can help explain attitudes toward safety, risk, new machines, and other workers. New research must also recognize that technology is meaningfully present even in workplaces that do not manufacture objects out of metal. We must also explore how gendered ideas about technology get translated between the workplace, the community, and the home.

The factory, of course, is not the only industrial workplace: the household may have industrialized differently but is unquestionably a site of work and of technological change, as noted above.[40] Beginning in the early eighties, scholars endeavored to document the work and technological activity of the household. They established that domestic tasks from laundry to childcare involve effort, skill, and sophisticated understandings of the material world, and have increasingly moved beyond the initial question of whether household technologies saved or increased labor in the home.[41] Scholars have explored differences between rural and urban women, and begun to compare domestic work across national boundaries.[42] Some

[40]This is the argument Ruth Schwartz Cowan set forth in "The 'Industrial Revolution' in the Home" (n. 2 above).

[41]Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York, 1983) explicitly qualified conventional boosterism of household innovations as laborsaving devices for women. For further discussion and examples see Susan Strasser, *Never Done: A History of American Housework* (New York, 1982). Canadian scholarship is especially strong in this area: Tanis Day, "Substituting Capital for Labour in the Home: The Diffusion of Household Technology" (Ph.D. diss., Queen's University, 1987); Suzanne Marchand, "L'impact des innovations technologiques sur la vie quotidienne des quebeçoises du debut du XXe siècle, 1910–1940," *Material History Bulletin* 28 (1988): 1–14. For the French case, see Robert L. Frost, "Machine Liberation: Inventing Housewives and Home Appliances in Interwar France," *French Historical Studies* 18 (1993): 109–30. On sewing, see Betty Ring, *"Let Virtue Be a Guide to Thee": Needlework in the Education of Rhode Island Women, 1730–1830* (Providence, R.I., 1983) and Roszika Parker, *The Subversive Stitch: Embroidery and the Making of the Feminine* (London, 1984); Rachel Maines, "The Tools of the Workbasket: Needlework Technology in the Industrial Era," in *Bits and Pieces: Textile Traditions,* ed. Jeannette Lasansky (Lewisburg, Penn., 1991). On technological changes in the household and women's role in them see also Maureen Ogle, "Domestic Reform and American Household Plumbing, 1840–1870," *Winterthur Portfolio* 28 (1993): 33–58.

[42]Cockburn and Fürst-Dilic, *Bringing Technology Home* (n. 28 above). On rural areas, see Joan Jensen, *Loosening the Bonds: Mid-Atlantic Farm Women, 1750–1850* (New Haven, Conn., 1986); Katherine Jellison, *Entitled to Power: Farm Women and Technology, 1913–1963* (Chapel Hill, N.C., 1993); Angela E. Davis, "'Valiant Servants': Women and Technology on the Canadian Prairies, 1910–1940," *Manitoba History* 25 (1993): 33–42; Glenda Riley, "In or Out of the Historical Kitchen? Interpretations of Minnesota Rural Women," *Minnesota History* 52 (1990): 61–71, and *The Female Frontier: A Comparative View of Women on the Prairie and the Plains* (Lawrence, Kans., 1988).

have turned attention to technologies of childrearing and childhood, and to the ways children's socialization and education replicates or redefines relationships between gender and technology, although these areas remain underexplored.[43] Recent work addresses the complex and reciprocal relationships between industrial home, industrial workplace, and industrial community. These studies seek not only to document the presence of technology, of work, or of women, but also to explain their chronic invisibility.[44]

Indeed, as Judy McGaw argued in 1982, running a household in a consumer society is "real work"—and consumption deserves the careful attention we are used to giving production in the history of technology.[45] Since then historians from a variety of fields have created a substantial literature on consumption, on which historians of technology can draw. The earliest of these studies focused primarily on marketing and advertising—the "production" side of consumption—rather than on the "work" of consumption in the sense that McGaw meant.[46] More recent studies have focused on consumers

[43]Karen Calvert, *Children in the House: the Material Culture of Early Childhood, 1600–1900* (Boston, 1992); Mary Lynn Stevens Heininger et al., *A Century of Childhood, 1820–1920* (Rochester, N.Y., 1984); Pursell, "Toys, Technology, and Sex Roles in America" (n. 21 above). See also the articles by Nina Lerman and Ruth Oldenziel in this issue.

[44]For more recent work see Jeanne Boydston, *Home and Work: Housework, Wages, and the Ideology of Labor in the Early Republic* (New York, 1990); Amelia Grace Preece, "Housework and American Standards of Living, 1920–1980," (Ph.D. diss., University of California, Berkeley, 1990); Arwen Palmer Mohun, "Women, Work and Technology: The Steam Laundry Industry in Great Britain and the United States, 1880–1920" (Ph.D. diss., Case Western Reserve University, 1992).

[45]McGaw, "Women and the History of American Technology" (n. 4 above), p. 827.

[46]See Stuart Ewen, *Captains of Consciousness: Advertising and the Social Roots of Consumer Culture* (New York, 1977); T. J. Jackson Lears, "From Salvation to Self-Realization: Advertising and the Therapeutic Revolution," *The Culture of Consumption: Critical Essays in American History, 1880–1980,* ed. Richard Wightman Fox and T. J. Jackson Lears (New York, 1983); Roland Marchand, *Advertising the American Dream: Making Way for Modernity, 1920–1940* (Berkeley and Los Angeles, 1985); Susan Strasser, *Satisfaction Guaranteed: The Making of the American Mass Market* (New York, 1989); Richard Tedlow, *New and Improved: The Story of Mass Marketing in America* (New York, 1990);William Leach, *Land of Desire: Merchants, Power, and the Rise of a New American Culture* (New York, 1993); T. J. Jackson Lears, *Fables of Abundance: A Cultural History of Advertising in America* (New York, 1994). On consumers in Europe, see Rosalind Williams, *Dream Worlds: Mass Consumption in Late Nineteenth-Century France* (Berkeley, 1982); Michael Barry Miller, *The Bon Marché: Bourgeois Culture and the Department Store, 1869–1920* (Princeton, N.J., 1981). For recent scholarship on advertising and marketing taking into account technology, gender, and consumers as active agents, see Susan Smulyan, *Selling Radio: the Commercialization of American Broadcasting, 1920–1934* (Washington, D.C., 1994); Carolyn Goldstein, "Mediating Consumption:

as active agents and on the role of gender in shaping consumer-producer relationships.[47] Historians have only begun to examine technology, consumption, and gender together. More emphasis is needed on the role of technological change in the reciprocal relationships of patterns of consumption and the nature of what is being consumed, on mediators between consumers and producers, and on consumers as active users and modifiers—what some have called "coproducers"—of technology. For instance, scholars have only begun to look at how technology and culture interact in consumers' decisions to repair broken or malfunctioning technology rather than replace it.[48] By moving away from a production- and business-oriented focus on the artifact alone, these more integrative approaches also move away from the old connotation of technology as inherently masculine.[49] They begin to break down old taxonomies,

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Home Economics and American Consumers, 1900–1940" (Ph.D. diss., University of Delaware, 1994); and Regina Lee Blaszcyk, "Imagining Consumers: Manufacturers and Markets in Ceramics and Glass, 1865–1965" (Ph.D. diss., University of Delaware, 1995).

[47] For an overview see Victoria de Grazia and Ellen Furlough, eds., *Sex of Things: Gender and Consumption in Historical Perspective* (Berkeley, 1996). For earlier work see William Leach, "Transformations in a Culture of Consumption: Women and Department Stores, 1870–1920," *Journal of American History* 17 (1984); Susan Porter Benson, *Counter Cultures: Saleswomen, Managers, and Customers in American Department Stores, 1890–1940* (Urbana, Ill., 1986). See also Dana Frank, *Purchasing Power: Consumer Organizing, Gender, and the Seattle Labor Movement, 1919–1929* (Cambridge, 1994); Jackie Dirks, "Righteous Goods: Women's Production, Reform Publicity, and the National Consumers' League, 1891–1919" (Ph.D. diss., Yale University, 1996); Elizabeth White, "Sentimental Enterprise: Sentiment and Profit in American Market Culture, 1830–1880" (Ph.D. diss., Yale University, 1996).

[48] On mediators, see Goldstein, "Mediating Consumption," and her article in this issue. On users see Susan J. Douglas, *Inventing American Broadcasting, 1899–1922* (Baltimore, 1987); Claude S. Fischer, *America Calling: a Social History of the Telephone to 1940* (Berkeley, 1992); Ronald Kline and Trevor Pinch, "Users as Agents of Technological Change: The Social Construction of the Automobile in the Rural United States," *Technology and Culture* 37 (1996): 763–795; Madeleine Akrich, "User Representations: Practices, Methods and Sociology," in *Managing Technology in Society*, ed. Arie Rip, Thomas Misa, and Johan Schot (London, 1995), pp. 167–84; Jellison, *Entitled to Power* (n. 42 above); Rachel Maines, "Socially Camouflaged Technologies: The Case of the Electromechanical Vibrator" *IEEE Technology and Society Magazine* 8 (1989): 3–11. See also Arwen Mohun and Roger Horowitz, eds., *His and Hers: Gender, Consumption, and Technology* (forthcoming), and Joy Parr's article in this issue.

[49] In *Culture as History: the Transformation of American Society in the Twentieth Century* (New York, 1984), Warren Susman uses the term "culture of production." A framework that takes the culture of production as its point of departure, focusing on the artifact itself, carries implicit gender biases, and misses crucial elements of the story. For an elaboration on this point see Ruth Oldenziel, "Object/ions: Technology, Culture and Gender," *Learning from Things*, ed. David W. Kingery (Washington, D.C., 1996).

and make room for new understandings of the interplay between gender and technology.

Exploring the vast terrain mapped out here means crossing old boundaries. It means recognizing, as we have suggested in the introduction to this issue, the importance of examining both sides of familiar dichotomies. Pairs such as masculinity and femininity, production and consumption, home and work—or even technological and social—must now be studied as reciprocal categories, dependent on and defined in relation to each other. In this view, balancing studies of production with separate studies of consumption, or studies of factories with studies of households, may be remedial—but is not the final outcome of sustained attention to the questions raised in this volume.

It is as impossible to understand gender without technology as to understand technology without gender. As the work gathered here suggests, future research must attend to masculinity as well as femininity, instead of assuming male normality and female exceptionalism. And it must attend to women's technological activity and technological power, recognizing women as important makers and doers of things whether in the kitchen or in the factory. But it is also crucial to recognize that gender is not the only social boundary used to render technological activity invisible, nor the only one bolstered by technological associations. If we pay attention to social ideologies and power in our studies of technological change we can begin to understand technological ideologies as well. Then we can address questions of why some technologies acquire status while others become invisible, and explore the mutual shaping of social categories and technology as systems for the distribution of power—systems which sometimes work in surprising ways. This integration across old boundaries emphasizes the connection in "technology and culture," the importance of context in understanding technology, and the importance of technology in understanding human society.